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feel much pleasure in communicating the mode of operation, by which any number of apertures, hardly visible to the naked eye, and of any length (*even a foot, if required*), may be made in any metal in *ten minutes!*

I am, Sir, &c. &c.

A. AIKIN, Esq.

HENRY WILKINSON.

Secretary, &c. &c.

The process consists merely in turning one cylinder to fit another very accurately, and then, by milling the outside of the inner cylinder with a straight milling tool of the required degree of fineness, and afterwards sliding the milled cylinder within the other, apertures are produced perfectly distinct, and of course of the same length as the milled cylinder. A similar effect may be produced on flat surfaces, if required.

H. W.

No. V.

COPAL VARNISH.

Letter from Mr. C. VARLEY, on Copal Varnish.

7 Charles Street, Clarendon Square,

SIR,

November, 1835.

THE letter of mine, in the first part of this volume, on the essential oil of spruce, was written in February 1827, when the first small quantity only had been received by the Society. My letter was accompanied with specimens

of copal in the different solvents therein mentioned, in order to exhibit the real facts to the Committee. That letter at this late date appears defective, in not being accompanied with any statement of what was *then* shewn to take place when different liquids are applied to copal. I will now give that account, premising that pure solutions of copal form the most perfect varnishes that have yet been used in the arts, from the fact that lumps of copal, or pure varnish when dried, may be exposed even to the atmosphere of London for years, or till they are obscured by dirt, and yet when washed will be found perfectly clean and as pure as ever; whereas mastic and mastic varnish (so much used by artists, to the certain injury of their pictures), when so exposed, become brown throughout their whole substance. Copal, with this most excellent quality, is the whitest of all the resins, and a sufficient quantity for artists may always be picked absolutely pure, and free from colour. Hence it becomes very desirable to effect its solution by menstrua not only in themselves colourless, but which will not add that injurious quality of becoming coloured throughout by exposure to our London atmosphere: for the copal varnish that has been so long in the market is made with oil which does add that injurious quality of acquiring a dirty colour quite through. Various methods of causing copal to dissolve in spirits, *i. e.* essential oil of turpentine, have been proposed, but they did not answer sufficiently well to bring it into the market. In 1813 I succeeded well enough to commence painting with solution of copal in spirit of turpentine, to the total exclusion of oil or any greasy matter.

Copal is not only difficult to dissolve, but, when well dissolved, it is liable to be precipitated in the form of a tough leathery substance, when a portion even of the original

solvent is applied to dilute it. Many artists who have tried to use it gave it up when this difficulty crossed them ; yet this may be avoided by a knowledge of the effect which different solvents have on copal. Very pure alcohol gives a strong and limpid solution of copal, in which long needles of crystals will appear, if left quiet for a length of time. This solution, when made as thick as can be used, may be applied as a varnish ; but the alcohol evaporates very quickly, and also acts as a solvent on the surface of the picture to which it is applied : such varnish, therefore, can only be used with particular care.

Oil of spike lavender (at present very expensive) quickly softens and then dissolves the small lumps of copal, so that it may be used as a varnish or as a vehicle for colours ; and yet if the solution, before it has been much disturbed, be carefully examined, the original form of the lumps may be detected as a nearly invisible jelly ; and, therefore, though it may be sufficiently dissolved for use, it is not a perfect solution : this effect is nearly obliterated when the copal is previously ground to a very fine powder, for that diminishes the size of the jelly-like masses. But, as oil of lavender acts powerfully, also, on the surface of the picture, the varnish should be as thick as can be used, in order that it may soon become too stiff by drying to act much on the surface.

Essential oil of spruce dissolves copal much like the oil of lavender, but is longer about it. Spirits of turpentine alone, if digested at the ordinary temperature on copal, will, in the course of a year, have softened the whole of it, and will have dissolved a portion into a pure solution, which forms a perfect and colourless varnish. This is what I first used for painting with : it perfectly preserves the colours, and retains its original transparency. A still

larger portion of copal is dissolved, if about one ounce of camphor is first dissolved in each pint of turpentine; and, when used as a varnish or to paint with, the camphor evaporates away with the turpentine, leaving no defect. These solutions are all made cold. Water, or moisture of some kind, is nearly always present in the copal and in the solvents; and the more it can be expelled, the more readily will the copal be dissolved: and, to prove that water is injurious, I took one portion of the same powdered copal that I subjected to the other solvents, and just wetted it with water, but not enough to be able to pour any from it: this I left a few hours, hoping it might soften some parts, and thereby liberate the rest. Another portion I just wetted with alcohol, and a third portion was left dry: to these three I added spirits of turpentine, and corked them close, and occasionally shook them up. That which had been first moistened with alcohol soon became soft, and in a week or two was dissolved, giving a varnish, a portion of which was ropy. The dry copal in turpentine was softened, and a portion dissolved: this required nearly a year to be soft enough to give up all that the turpentine could dissolve; whilst the portion that had been moistened with water never would dissolve in the turpentine. By shaking the vial, portions had adhered to the sides; but these were only softened enough to become smooth as though they were melted to the sides, but not to run down; and this sample, year after year, exhibited the same appearance: the re-adhesion was just enough to obliterate the pulverised character, and no more. Thus, water is shewn to be a formidable opponent to the solution of copal, and alcohol a very great assistant to its solution in turpentine.

The solubility of copal, in either oil of spruce or oil of

lavender, is likewise much improved by first wetting the powder with alcohol, and the varnishes so prepared dry quickly and completely. It is known to many, that oil of turpentine, by long exposure to air, becomes so thick as to appear like a strong varnish; and glass and china-painters have availed themselves of this property, it being stiff enough to hold their colours on, and yet, with the heat of burning them in, will all dry away, leaving no coally substance to burn and damage their colours, either by soiling or decomposing them. If powdered copal, in sufficient quantity, is added to the oil of turpentine while so exposed to air, the whole will be softened to a consistence like treacle. This increased solvent power is not owing to what the oil has lost by evaporation, for heat precipitates the copal, or most of it, and restores to the turpentine its original thinness; or if fresh oil of turpentine be added, it will also precipitate the copal, and leave the fluid thin about it. A small quantity of oil of turpentine will soften copal all through, leaving it transparent, but stiff and ropy; a large quantity poured on a small quantity of copal (and more quickly, if it is boiled on it) will dissolve one portion, and leave the rest in a white crusty powder, or much like dry crumbs of bread, very fragile, as though it was quite an insoluble substance. Oil of turpentine, thickened by what it has dissolved of one portion of copal, will become a better solvent of a further portion. The older these solutions are, the more strongly do they indicate a smell of ether when the bottles are opened. Hence, copal appears to consist of two parts: one soluble in the essential oils, and its presence appears requisite to enable the fluid to dissolve the other part; but, by carefully avoiding moisture, and well softening the copal with alcohol, I am now enabled to dissolve the

whole in oil of turpentine, so as to use it all as a varnish ; though I would much rather have, for this purpose, oil of spruce.

I have shewn above that water resists solution, and, I think, the tendency to precipitate by mere dilution is partially occasioned by the presence of moisture in the additional solvent. Alcohol alone being a good solvent, may, on that account, be supposed to aid the other solvents ; but I believe it also acts by taking possession of any moisture that may be present.

The oil-varnish makers subject their oils and their resins to heat continued sufficiently long to expel all moisture, and then the two will more readily combine, and form a varnish of any required strength ; but all these are more or less coloured by the heat. In the cold, I can obtain varnish quite free from colour, but with heat I never could avoid some colour ; therefore, my endeavours were chiefly directed to obtain solutions without heat, yet the varnish that Mr. Neil prepared for the Society with oil of spruce and copal, the moisture of which he expelled by heat, was good, and had so little colour, that few painters would object to it.

I have said above, that I use these essential-oil varnishes as the only vehicle to mix up my colours for painting ; but they dry so quickly, that I should either lose much paint or much time if I had not found a ready re-solvent ; and here moisture, if present, shews its mischief. When the paint becomes too stiff, common oil of turpentine will occasionally thin it, but it frequently precipitates it. I next tried ordinary spirits of wine, and found that it would quickly dilute the paint once or twice, or re-dissolve it if quite hard ; but when oftener applied, it precipitated the paint and copal, like leather,

leaving a clear fluid above. Knowing that this process conveyed a little water each time it was added, I took good alcohol, and found it would dilute or re-dissolve the dry paint very often (enough to answer my purpose); but even with this, the paint and copal would sometimes go down; suspecting this might be owing to moisture, I dried the paint with a heat a little above boiling water, and then the alcohol acted as well as ever in re-softening the paint. I therefore conclude, that in this case water is the chief cause of the precipitation.

The presence of water is likewise very injurious in the solution of lac in spirits of wine, commonly called lacquer, and chiefly used for varnishing polished brass. If the spirit contain so much water as to be only just able to dissolve the lac, it can scarcely be used; for it will require the brass to be made so hot, to drive off the water with the spirit, that it will render the varnish rough; and if the usual heat be employed, which is such as can just be handled, the water will remain after the alcohol is driven off and will prevent the lac from adhering to the brass; whilst the purer the alcohol, the lower is the heat that will serve to drive it off, and leave the lac bright, and uniformly spread over the brass so clear as to be invisible, and as firmly united as if it was melted on it, which, in fact, it is, by the agency of the alcohol. Another evil in lacquer is its being too thick, that is, in not having alcohol enough to allow time for spreading on and removing the brush before the varnish has become so thick as to stick some of the hairs fast.